UNITED STATES GOVERNMENT STATUS REPORT

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United States

State of Motor Vehicle Safety

In 2009, 33,808 fatalities occurred in the U.S. as a result of motor vehicle crashes. This is the lowest number of deaths since 1950. The number of motor vehicle-related fatalities in 2009 fell 9.7 percent from the 37,423 fatalities in 2008.

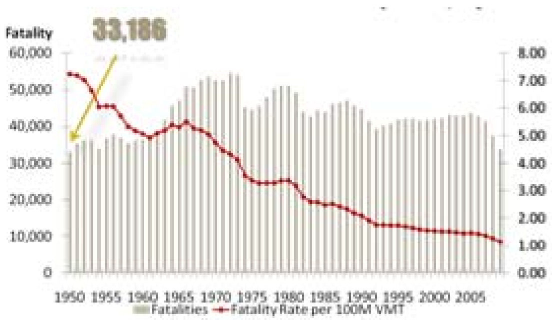


Figure 1. Fatalities and Fatality Rate per 100 Million Vehicle Miles Traveled Between 1950 and 2009.

Even more impressive, the fatality rate per 100 million Vehicle Miles Travelled (VMT) in 2009 fell to a historic low of 1.13 (see Figure 1). This downward trend is continuing, and a statistical projection of traffic fatalities in 2010 showed that an estimated 32,788 people died in motor vehicle traffic crashes

The total number of police-reported crashes in the U.S. in 2009 was estimated by the National Automotive Sampling System (NASS) General Estimates System (GES) to be 5.5 million, resulting in 2.22 million persons being injured. In recent years, the estimated number of injuries has decreased, as has the injury rate, based on VMT. In 2009, the injury rate fell to 74 people per 100 million VMT.

These improvements in motor vehicle safety are due in part to the collective efforts of the operating agencies of the Department of Transportation[1], the States, automobile manufacturers, and other private sector organizations. NHTSA's engineering efforts combined with its educational and enforcement programs that ensure proper compliance with the U.S. regulations have contributed to this significant achievement in safety.

Table 1 provides a breakdown of all motor vehicle fatalities by person type.

Table 1. 2008-2009 U.S. Fatalities by Person Type.

Motorists and Non-occupants Killed in Traffic Crashes				
Description	2008	2009	Change	% Change
Total*	37,423	33,808	-3,615	-9.7%
Motorists Killed in				
Passenger Vehicles	25,462	23,382	-2,080	-8.2%
Passenger Cars	14,646	13,095	-1,551	-11%
Light Trucks	10,816	10,287	-529	-4.9%
Large Trucks	682	503	-179	-26%
Motorcycles	5,312	4,462	-850	-16%
Non-occupants Killed				
Pedestrians	4,414	4,092	-322	-7.3%
Pedal Cyclists	718	630	-88	-12%
Other/Unknown	188	150	-38	---

Source: FARS 2008 (Final), 2009 Annual Report File (ARF)
* Total includes occupants of buses and other/unknown vehicles not shown in table

In spite of these hard-fought gains in vehicle safety, motor vehicle crashes continue to be a major public health concern. For example, motor vehicle crashes are the number one cause of death in ages 8 to 34, and among all age groups, are the third leading cause of fatalities (with cancer and heart disease as the #1 and #2 cause respectively).

For these reasons, NHTSA remains fully committed to its mission of working with industry and the public to improve motor vehicle safety through a coordinated effort involving research, education, enforcement, and rulemaking.

Status of Current NHTSA Research Programs

NHTSA research priorities are driven by problem size (as defined by crashes, injuries and fatalities attributable to specific vehicle or driver issues), by technical innovations that present new opportunities for improving safety, and by changing driver behavior and demographics. These technical, market and economic factors are used to develop three-year vehicle safety priority plans, and 5 year and longer term strategic plans. Aligned with DOT and NHTSA goals, Figure 2 illustrates the program development process among NHTSA data collection, research, rulemaking, and enforcement activities. Collectively, planning teams continuously strategize, prioritize and implement research programs, furthering the agency's

[1] The National Highway Traffic Safety Administration (NHTSA), the Federal Motor Carrier Safety Administration (FMCSA), the Federal Highway Administration (FHWA), Federal Transit Administration (FTA) the Federal Railroad Administration (FRA) and the Research and Innovative Technology Administration (RITA)

goals to reduce fatalities and injuries.

Figure 2. NHTSA Research Planning Process.

Strategic program plans and roadmaps are typically developed with outcomes aimed at regulatory decisions and implementations. Current plans and roadmaps include a Motorcoach Safety Plan, Connected Vehicles and Vehicle-to-Infrastructure Roadmap, Human Factors Roadmap, Distraction Plan, Biomechanics Plan, Alternative Energy Vehicle Safety Plan, Crashworthiness Plan, and Elderly Occupant Plan. Key programs are described in the sections that follow.

The Haddon Matrix is the most commonly used paradigm in the injury prevention field. Developed by William Haddon in 1970, the matrix provides a comparison of factors before, during and after an injury or death. By utilizing this framework, one can think about the relative importance of different factors, interventions, or programs. Figure 3 shows the NHTSA research program areas comprising an expanded Haddon matrix. A fundamental change to the Haddon matrix was adopted, whereby the pre-crash category is now composed of normal driving and crash imminent conditions. The expanded matrix better matches the breadth and scope of our crash avoidance and crash worthiness research programs.

Crashworthiness Research

Low Offset / Oblique Frontal

In June 2009, the National Highway Traffic Safety Administration (NHTSA) published a report that investigated the question "why, despite seat belt use, air bags, and the crashworthy structures of late-model vehicles, occupant fatalities continue to occur in frontal crashes (Rudd et al, 2009)." The report concluded that aside from a substantial proportion of these crashes that are just exceedingly severe, the primary cause was poor structural engagement between the vehicle and its collision partner: corner impacts, oblique crashes, impacts with narrow objects, and heavy vehicle underrides.

By contrast, few if any of these the 122 fatal crashes examined in the report were full-frontal or offset-frontal impacts with good structural engagement, unless the crashes were of extreme severity or the occupants were exceptionally vulnerable. As a result of the NHTSA study, the agency stated its intent to further analyze small overlap and oblique frontal crashes in its Vehicle Safety Rulemaking & Research Priority Plan 2009-2011 published in November 2009 and updated in April 2011 for 2011-2013 (NHTSA, 2011a).

	Crash Avoidance		Crashworthiness	
	NORMAL DRIVING	CRASH IMMINENT	CRASH EVENT	POST-CRASH
PASSENGER CARS/TRUCKS	• Driver Distraction • Driver Support Systems • Blind Spot Detection • Alcohol Detection • Drowsy Driver Detection •Crash Warning Interfaces •…	•Forward Crash Warning •Lane Departure Warning •Automatic Braking •Lane Keeping •V2V & V2I •Crash Warning Interfaces •….	• Advanced Airbags •Dynamic Rollover • Oblique/Off-set Frontal • Adaptive Restraints • Child Side Impact • Elderly Occupants • ….	• Auto Crash Notification (ACN) • Advanced ACN • Medical Outcome (CIREN) • First Responder Safety
HEAVY VEHICLES - Truck/Bus	• Driver Distraction • Drowsy Driver Detection • Enhanced Vision Systems • Blind Spot Detection •Crash Warning Interfaces	• ESC/RSC •Forward Collision Warning •Lane Change Warning •V2V & V2I •Crash Warning Interfaces	• Underride	• Electronic Data Recorders • ACN?
MOTORCYCLES	• Conspicuity	• ABS/CBS • V2V	• Helmet Use • Airbags	• ACN?
PEDESTRIANS	• Quiet Car Detection • Lighting Systems for Pedestrians	• Pedestrian Warning • Automatic Braking • P2V	• GTR Hoods/Bumpers	•ACN?
BATTERY ELECTRIC VEHICLES	• Charging Safety • Lithium Ion Battery	• Shut-Down Strategies	• Lithium Ion Battery • Electrical Isolation	• First Responder Safety
ELECTRONICS RELIABILITY & SECURITY	• Fail-Safe Strategies • Software Reliability • Fault Detection & Reporting & Driver Vehicle Interface	• Control System Management Strategies & Driver Vehicle Interface	• Control System Management Strategies	• Electronic Data Recorders

Figure 3. Expanded Haddon Matrix describes NHTSA Crash Avoidance and Crashworthiness programs.

NHTSA performed a detailed analysis of low offset/oblique non-fatal frontal cases taken from the National Automotive Sampling System (NASS) and the Crash Injury Research Engineering Network (CIREN). The real-world analysis of the crash data above and this study indicated that occupant kinematics is a concern because of the oblique nature of the impact. An interesting finding from the NASS/CIREN analysis showed a high rate of acetabular fractures sustained without have a concurrent femur fracture. Therefore, it was thought with the improved bio-fidelity and advanced instrumentation the THOR-NT crash dummywould better represent real-world occupant kinematics and injuries.

NHTSA has initiated a research program to investigate crash test protocols that replicate real-world injury potentials in low offset and oblique frontal crashes. NHTSA is investigating two test procedures for the low offset program. The first is a moving deformable barrier (MDB) into a stationary vehicle. In this procedure the outer edge of the MDB is expected to not engage the main longitudinal structure of the vehicle. A slight angle is added to the stationary vehicle to keep the MDB engaged during the impact. The second procedure is a vehicle at a slight angle being pulled into a pole. The test procedure that NHTSA is evaluating for oblique frontal crashes is an MDB into a stationary vehicle positioned at a certain angle. This angle is used to represent the obliqueness seen in the real world, and the overlap is such to engage one of the main longitudinal structures of the vehicle.

Heavy Truck Underride

In the 2009 study, rear underride occurred because the trailer underride guard was insufficient to prevent the underride. NHTSA is conducting a detailed analysis of all fatal underride crashes that occurred in 2008 (using the Trucks in Fatal Accidents, TIFA, database) to understand the scope of the problem. This study is collecting information on the design and safety performance of the truck underride guards.

In addition, in October 2010, the agency published the results of a study to determine the effectiveness of FMVSS No. 223/224 compliant underride guards at preventing fatalities and serious injuries in crashes where a passenger vehicle impacts the rear of a tractor-trailer (Allen, 2010). The main findings of the study suggest that while some states showed a decrease in fatalities and serious injuries in rear underride crashes, the decrease was not statistically significant due to small sample size. Further, the study was unable to establish a nationwide downward trend (since the introduction of the FMVSS No. 223/224 standards in 1998) in fatalities when a passenger vehicle rear-ends a tractor trailer.

Dynamic Rollover Protection

NHTSA is conducting a long-term project to evaluate the feasibility and development of a dynamic rollover test capable of evaluating occupant kinematics, injury mechanisms, and safety countermeasures during rollover crashes. This project is utilizing crash investigation, injury mechanism analysis, reconstruction, computer simulation, and a unique test environment to develop a more thorough understanding of occupant motion and injury patterns in rollover crashes. This work should facilitate future countermeasure development.

Child Passenger Safety

Using NHTSA's Fatality Analysis Reporting System (FARS) data files for the years 2003-2008, the agency estimated that 29 % of fatalities among 0-3 year old child passengers in motor vehicle crashes were in frontal crashes while 28 % were in side impact crashes. Side impacts are less common than frontal impacts yet they result in a comparable amount of fatalities. From NASS-CDS data files it was determined that 55% of AIS2+ injuries in 0-12 year old children were to the head and face, while 28% of AIS2+ injuries were to the torso.

NHTSA has been conducting research on the protection of children in side impact crashes. Much of that research has focused on developing a test procedure to evaluate CRS performance in side impact crashes. A side impact sled buck, based on a design by Takata, is currently being evaluated. Sled buck test parameters are currently being refined, based on crash tests and interior door component test results. The agency is also reviewing the current FMVSS No. 213 test procedure to determine the viability or advisability of increasing the simulated frontal impact speed from 30 mph to 35 mph and updating the existing test seat fixture.

In response to consumers' needs and state laws that require children to be in some form of child restraint until 6-8 years of age, child seat manufacturers have begun to increase the upper weight limits on many of their CRS models. In addition to higher weight usage limits, the CRS themselves tend to be heavier than the lower rated models. The agency is conducting research to assess the performance capability of the Lower Anchorages and Tethers for Children (LATCH) systems when used with these higher weight rated CRS models.

Children can strike side and other interior surfaces of the vehicle. Research efforts are underway to investigate the injuries from contact with lower door sections and vehicle interior components to see if there is need to increase the protection for rear occupants.

Lithium Ion Battery Safety

NHTSA's safety research program for electrically propelled vehicles will focus on lithium ion based rechargeable energy storage systems (RESS). These lithium ion RESS are anticipated to be used in most near term future applications of hybrid electric vehicles (HEV) and battery electric vehicles (BEV). NHTSA's approach is to develop performance criteria to analyze safety in RESS equipped vehicles in all operating conditions including battery charging, normal operation, and abnormal operation such as crash and post-crash events. NHTSA's plan is to build upon experience from industry and the U.S. Department of Energy (DOT) by analyzing failure modes through a failure modes and effects analysis (FMEA), develop repeatable performance based test procedures and safety metrics to quantify the failure modes, and analyze the performance characteristics of an effective RESS control system.

Countermeasures for "Lightweighted" Vehicles

Future fuel economy requirements are expected to increase in stringency and require significant changes to vehicle design and possibly the distribution of vehicle types sold in the future. The crashworthiness of the new vehicle designs is anticipated to meet all major safety standards, but existing standards do not encompass the entire safety problem in the US fleet. The range of vehicle weights is expected to increase as lighter, more fuel efficient vehicles enter the fleet. The vehicle weight difference will translate directly into widely different crash severity for vehicle-to-vehicle crashes.

One challenge for lightweight fuel efficient vehicles is to enhance structural and restraint performance to accommodate a larger change in velocity and higher deceleration. Research is underway to evaluate the crash performance of potential lightweight vehicle designs. Finite element crash simulations are being used to study vehicle-to-vehicle crash safety performance. These simulations will be used to study potential safety countermeasures to maintain or improve the crash performance for future lightweighted vehicles.

Advanced Restraints

A recently completed study by the Crash Avoidance Metrics Partnership (CAMP) Advanced Restraints System (ARS) consortium demonstrated the ability of adapting restraints to occupant size, position, pre-crash information, and crash type. The ARS project assumed the occupant size and occupant position and deployed the restraints accordingly.

This next phase of this project also intends to utilize advanced restraints to adapt to varying occupant and crash pulse conditions. However, this project intends to develop an adaptive system (restraints, sensing technology, etc.) that will use real-time occupant and crash pulse sensing information to actively make decisions on how the restraint systems should function. Typical restraint system development, like that of CAMP-ARS, involves sled testing where the occupant (size, weight, position) and crash pulse (severity, direction of force) information is known in advance and restraint systems are remotely deployed based on this knowledge. The distinction of using "real-time" occupant and pulse data to "actively" deploy restraint systems in the current project is a unique and focal point of this effort.

Rear seat restraint designs have not kept pace with the advances that have occurred for front seating positions. NHTSA Research has included rear seat occupants in a series of full-scale frontal vehicle tests to evaluate the performance of the rear seat restraints. NHTSA is also studying the merits of advanced restraint systems, such as inflatable belts, load limiters, and pre-tensioners, for improving protection for adults in the rear seats as different technologies become available.

Motorcoach Research

NHTSA has been studying the issue of motorcoach occupant safety for several years. On average, motorcoach crashes cause 19 deaths annually. Ejection from the motorcoach is common to both frontal and rollover type crashes accounting for about half of all motorcoach passenger fatalities. Ejection is particularly harmful in fatal crashes, with rollover accounting for 75 percent of those fatalities. Installing seat belts would be the most direct method of retaining passengers within the motorcoach. The agency published a NPRM on this issue in 2010 (NHTSA, 2010a).

The agency is conducting research into ejection through window openings. Component tests using a guided impactor, are being carried out to evaluate the performance of various window glazing and latch designs.

Biomechanics Research

Biomechanics

NHTSA's Human Injury Research and Applied Biomechanics Divisions have led NHTSA's biomechanics research efforts over the past 35 years. The current research efforts are documented in the Biomechanics Research Plan, which will be available on the NHTSA Research website. This plan prioritizes the research activities based on the analysis of NHTSA's many crash databases including an in-depth analysis of crashes using the CIREN database. The research priorities, in part, were established on the basis of frequency, cost, and fatal outcome of the respective crash-related injuries.

Based on the analyses, the plan has developed a set of projects that will produce deliverables and results that can be used to support NHTSA's rulemaking initiatives (NHTSA, 2011a). Recent data analysis has indicated continued need to address the following areas: Child, Adult and Elderly Occupant Injury Mechanisms. This work will lead to injury assessment methods including advanced

Anthropomorphic Test Device (ATD) research and associated injury criteria.

Injury Mechanisms Research

Research continues to focus on injury outcomes / mechanisms and the development of new and improved devices (e.g. ATD's) to address the continuing issues observed in frontal, side, rear, and rollover crashes. For the adult occupant, head/brain and thoracic injuries continue to be necessary focus areas as supported by real-world crash data analysis.

These efforts include an analysis of mild traumatic brain injury and the criteria that may be used to assess it. Continued analysis of data using the SIMon (**S**imulated **I**njury **Mon**itor) model for the brain injury has supported the development of a BRain Injury Criteria (BRIC) that utilizes angular kinematics of the head derived from the to predict the probability of brain injury (Takhounts et al., 2011). Related research, including the analysis of football player head impacts and axonal strain related to diffuse axonal injury, will allow for further enhancements of the SIMon head model and for development of improved brain injury criteria.

Thoracic injury research continues as these injuries continue to be a major source of occupant harm in frontal, side and rollover crashes. Ongoing efforts in this area include the development of a standardized sled test that can be used to better define a more crash relevant thoracic response that can be used for future dummy development. Efforts are also looking to document the multi-point/multi-axis response of the thoracic to loading in support of advanced thoracic injury criteria. Finally, efforts are also focusing on the response of the thorax under oblique loading. These efforts may help to provide response requirements and injury criteria.

Anthropomorphic Test Device (ATD) Research

NHTSA's research efforts have focused on numerous updates and evaluations of adult ATDs. Included amongst these, are the short-term enhancements that have been implemented on the THOR, an advanced 50th percentile male frontal impact dummy (Figure 4). These short-term enhancements have been implemented to improve THOR response and usability and have been applied to an existing dummy, which is currently under evaluation. The results of these enhancements may encourage additional international use and acceptance of the THOR dummy. Similar to the 50th male, the 5th percentile female version of THOR will be subjected to a test protocol aimed to further assess its biofidelity and to identify requirements for any design enhancements that may be necessary in order to make the dummy suitable for use in standardized testing.

NHTSA has completed an assessment of WorldSID (50th percentile male) relative to biofidelity and crash test capability. The WorldSID 50th male shows improved biofidelity over existing side impact dummy designs and has performed well in current Agency side impact tests. Similar efforts are being done with the WorldSID 5th female to compare biofidelity versus existing ATDs.

A test series to determine biofidelity of rear impact dummies including the 50th percentile male BioRID dummy has been completed and analysis is in progress. The Human Injury and Applied Biomechanics Divisions will assess the test results to determine potential injury criteria and calibration and certification procedures for these dummies and continue to work with the international vehicle safety community to complete the analysis.

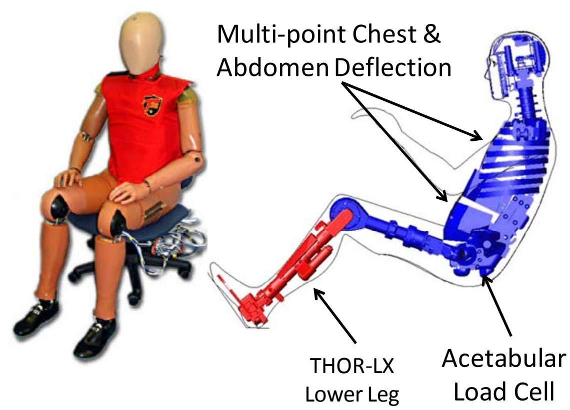


Figure 4. THOR 50th percentile male dummy.

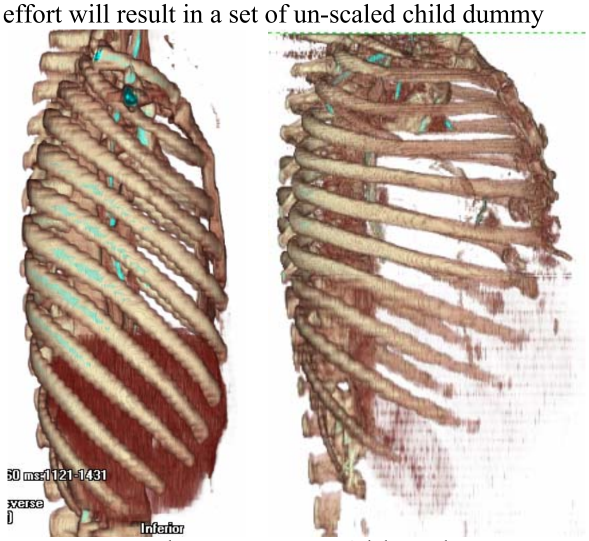
Finally, NHTSA also has been completing efforts in support of child ATD development. First, NHTSA has supported the implementation of a revised neck, thorax and pelvis for the Q3s, 3-year-old side impact child dummy. The updated Q3s is currently undergoing evaluations for biofidelity, repeatability, reproducibility, and durability. Additionally, work continues to assess other child dummies such as the Hybrid III 6- and 10-year-old to include in future regulation as well as research to enhance the response of these dummies.

Vulnerable Occupant Injury Research

Vulnerable occupants include children, elderly occupants, and pregnant occupants. Dedicated field data analysis continues to help understand the issues and determine research efforts required. Recent CIREN and NASS-CDS data shows thoracic injuries are prevalent for older occupants. Research efforts to quantify the effects of changing thoracic geometry and material properties on the tolerance to thoracic loading as a person ages is in process (Figure 5).

Understanding the fragility (tolerance) and frailty (final outcome) for older occupants may help lead to design of tests and injury criteria that are more consistent with prediction of injury. This can lead to improved restraint design that may help to mitigate injuries in this rapidly expanding cohort of vehicle occupants.

With regard to children, NHTSA is leading a multi-center research effort to collect and document new child anthropometry, injury criteria and response data that together can be used in the development of advanced child dummies. Areas of study include the head, neck, shoulder, thorax, and abdomen. This effort will result in a set of un-scaled child dummy



Young Thorax Older Thorax

Figure 5. Images showing differences in geometry of a younger versus older thorax.

response requirements and injury tolerance data that can be used in support of advanced child dummy development.

Crash Injury Research and Engineering Network (CIREN) Developments

CIREN continues to explore new ways to enhance NHTSA's and the public's understanding of injury causation in crashes and refining the capability to define injury criteria. The Biomechanics Tab (Bio Tab) for analyzing and deducing injury mechanisms objectively is now in routine use and has been applied to specific injury producing events such as belted rollover occupants. This application has been aided by 3-Dimensional imaging techniques for injury identification as well as initial efforts to truly integrate the CIREN network through streaming Internet video of case reviews to all centers. This allows sharing of expertise and opinions on crash, vehicle and medical results to further enhance the data quality and richness. Also, efforts to link CIREN data with NASS-CDS may provide a powerful tool for future analysis of crash and injury data to create injury risk functions and ultimately, injury criteria. Finally, initial analysis of CIREN cases with information from Event Data Recorders (EDR) is being used to understand how crash information may be used to alert emergency response teams regarding injury severity so that better decisions can be made regarding transport of crash victims to appropriate centers of care.

Advanced Automatic Collision Notification (AACN)

In a collaborative effort between various NHTSA offices and the Centers for Disease Control (CDC), efforts are underway to study many considerations related to the implementation of AACN. It is expected that crash information transmitted from AACN systems to the appropriate response and medical personnel has the potential to significantly improve the outcomes of crash victims. The current NHTSA / CDC efforts are focused on documenting the effectiveness of current injury predicting algorithms and to make recommendations for future data elements and outcomes that should be used to predict the need for trauma center resources. Additionally, efforts are attempting to document the potential benefits of and considerations related to the integration of AACN data into emergency medical service (EMS) and trauma systems.

Crash Avoidance Research

Overview

NHTSA's crash avoidance mission seeks to advance the scientific knowledge of how to save lives, prevent injuries, and reduce economic costs by researching the effectiveness of various crash avoidance technologies. The program includes performing human factors/engineering studies to understand how such technologies can be best integrated into the driver-vehicle environment so as to aid the driver while minimizing distraction or other negative consequences. The results of this research are used by the Agency to improve highway safety through the regulatory process, consumer information activities and other means. This program relies heavily on problem sizes estimated from crash data that are collected, reduced, and maintained by the National Center for Statistics and Analysis (NCSA). The crash avoidance research program is implemented through a combination of contracts with research organizations, cooperative agreements with industry and university safety organizations, and internal testing and analysis.

A critical component of the crash avoidance research program is to understand the interaction of the driver, the vehicle and the environment in pre-crash (normal driving and imminent), conditions. Figure 6 illustrates the vulnerable areas around a vehicle that can be addressed by crash avoidance technologies. The crash avoidance research program has three main focus areas: Advanced Technologies (light vehicle focus), Heavy Vehicles, and Human Factors as follows:

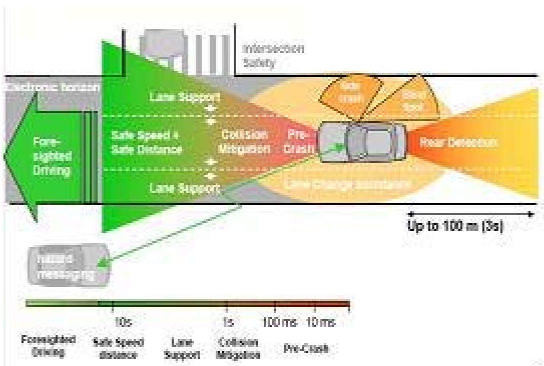


Figure 6. Vulnerable Areas Addressed by Crash Avoidance Technologies.

Advanced Vehicle Technologies

A key priority of NHTSA's light vehicle advanced technologies research program is intelligent vehicle technologies. This research is pursued as part of the Department's Intelligent Transportation Systems (ITS) Program. Research in the ITS area has focused on vehicle safety communications (VSC) and the integration of vehicle based safety systems (IVBSS).

Additional priority areas include: Developing new and improved methodologies to evaluate the safety impact of advanced crash avoidance technologies (ACAT); Electronics reliability and cybersecurity; and applied research to develop performance requirements and associated objective tests to support agency regulatory decisions.

Vehicle Safety Communications (VSC)

The U.S. Department of Transportation has conducted extensive research on the effectiveness of vehicle-based autonomous collision countermea-sures for rear-end, road departure, and lane-change crashes. However, the systems have inherent limitations such as misidentification of stopped cars and out-of-path obstacles. VSC, paired with accurate vehicle positioning may overcome these shortcomings and improve safety system effectiveness by complementing or, in some instances, providing alternative approaches to autonomous safety equipment. NHTSA is exploring how both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications can enable improved effectiveness of active safety systems.

NHTSA is conducting a collaborative research effort with a consortium of automobile manufacturers to facilitate the development and deployment of effective V2V communication safety systems. Figure 7 illustrates the V2V concept.

This project is developing safety applications, addressing interoperability issues and evaluating safety benefits.

Figure 7. Vehicle to Vehicle Communications.

In 2011, USDOT will initiate the Safety Pilot Program. Safety Pilot is intended to establish a real world model deployment test site for enabling wireless communications among vehicles. The Pilot uses rodside equipment to generate data, which will enable driver safety warning systems. The deployment site will encompass vehicles of various types that include a mix of integrated, retrofit, and aftermarket vehicle safety systems.

The goals of the Safety Pilot Program are to:

- Supplement benefits data in support of NHTSA 2013 Agency Decision on V2V Communications with Real World Field Data.
- Support real world V2V and V2I safety applications with a data rich environment.
- Create public awareness & determine user acceptance.

Anticipated outcomes include:

- Obtaining empirical data for estimating benefits and user acceptance in support of future federal policy actions.
- Establishing a public database of archived road network data for supporting development of additional safety, mobility, and environmental applications.
- Establishing multiple supplier sources for safety devices and roadside infrastructure.
- Develop a better understanding of the operational policy issues associated with the deployment of V2V and V2I applications

Integrated Vehicle Based Safety Systems (IVBSS)

About 3.6 million rear-end, road departure, or lane change crashes occur each year. Of these 3.6 million, 27,500 crashes result in one or more fatalities. These fatal crashes represent about ¾ of all fatal crashes.

The widespread deployment of advanced integrated driver assistance systems has the potential to reduce rear-end, road departure, and lane change collisions by 48 percent. Integrated systems can provide better hazard information from multiple sensors and provide coordinated warnings to reduce driver distraction. The IVBSS program is a four-year initiative that began in November 2005. This two phase cooperative research program was conducted by an industry team led by the University of Michigan, Transportation Research Institute (UMTRI).

Results from the Phase I Vehicle Verification Tests determined that the prototype system met its performance guidelines and was safe for use by ordinary drivers in a field operational test. The Phase II Field Operational Test started in January 2009. The light-vehicle and heavy-truck field operational tests examined the effect of a prototype integrated crash warning system on driver behavior and driver acceptance. Both platforms included three integrated crash-warning subsystems: forward crash; lateral drift; and lane-change/merge crash warnings. The light-vehicle platform also included curve-speed warning.

Integrated systems were introduced into two vehicle fleets: 16 light vehicles and 10 Class 8 tractors. The light vehicles were operated by 108 volunteer drivers for 6 weeks, and the heavy trucks were driven by 18 commercial-truck drivers for a 10-month period. Each vehicle was instrumented to capture detailed data on the driving environment, driver behavior, warning system activity, and vehicle kinematics. Data on driver acceptance was collected through post-drive surveys and debriefings.

Key findings indicated that use of the integrated crash warning system resulted in improvements in lane-keeping, fewer lane departures, and increased turn-signal use. Both the passenger car and commercial drivers accepted the integrated crash warning system and felt they benefited from improved awareness of vehicles around them. No negative behavioral-adaptation effects from using the integrated system were observed in either driver group.

Advanced Collision Avoidance Technologies (ACAT)

In September 2006, the ACAT program was established to identify new or emerging advanced technologies and to estimate the safety impact of these technologies. The ACAT program developed and applied a framework to understand the safety potential for vehicles that are equipped with emerging advanced safety technologies. This framework was used to estimate safety benefits.

Safety benefits assessment utilized a combination of national crash databases, data gathered from previous projects, data collected from objective testing, and data generated from computer simulations. Objective testing included test track testing and driving simulator testing.

In 2009, NHTSA completed four projects with teams led by automobile manufacturers, which focused on technologies that address frontal collision mitigation (primarily rear-end crashes), back-over prevention, and lane departure warning.

In June 2011, NHTSA will complete two remaining projects with teams led by automobile manufacturers, which focused on technologies that address head-on collision mitigation, lane departure prevention, and blind spot detection.

Electronic Control Systems

Electronic control systems in vehicles raise concerns for driver safety related to system reliability, cyber security, and driver-vehicle interfaces. Crash avoidance program are addressing strategies for fail safe operation, diagnostics, software reliability, hardware validation, and electromagnetic compatibility. Cyber security challenges address on-board tamper-proofing, hacking and malicious external control. Driver-vehicle interaction challenges address concerns about the transition of control between vehicle and driver arising from advances in V2V and V2I sensing, and driver responses to control failure warning and notification.

Heavy Vehicle Research

NHTSA's heavy vehicle research program is targeted at examining the functionality, performance, and safety benefits of a variety of advanced collision avoidance technologies as well as crash mitigation systems for heavy vehicles. The heavy vehicle research program addresses safety technologies that are both commercialized but perhaps not widely deployed, prototype and next generation safety systems, and multiple vehicle platforms including tractor-trailers or combination vehicles, straight trucks, buses, and motorcoaches.

Electronic Stability Control for Heavy Vehicles

In the area of crash avoidance, NHTSA's heavy vehicle program is evaluating the performance benefits of electronic stability control (ESC). ESC systems can reduce loss of control crashes which often result in rollover or jackknifing.

Specific studies underway include testing at NHTSA's Vehicle Research and Test Center in Ohio to develop objective evaluation and performance measurement procedures (Figure 8). We are also completing safety benefit studies using hardware-in-the loop simulations, and clinical analysis of large truck crash reconstruction data to determine the effectiveness of stability control systems over a wide range of conditions.

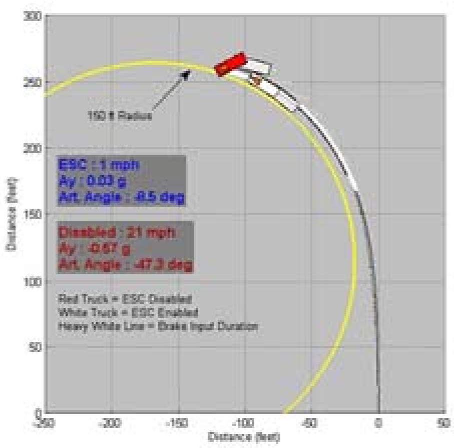


Figure 8. Stability Control Testing.

Forward Collision Warning (FCW), Collision Imminent Braking (CIB), and Lane Departure Warning (LDW) Systems.

NHTSA is also developing test procedures and evaluating the performance of current generation forward collision warning (FCW) systems with Collision Imminent Braking (CIB), as well as prototype systems that combine radar and optical sensors to improve object recognition, reduce "nuisance" warnings, and enhance autonomous braking performance. The work includes determining how such systems perform under a variety of pre-crash scenarios (Figure 9). Similar work is also underway for light vehicles.

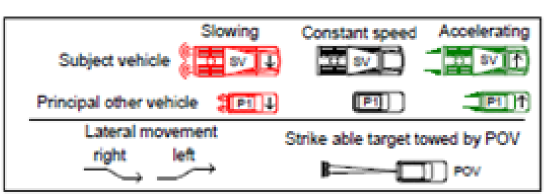


Figure 9. Examples of Pre-crash Scenarios.

Similar research is planned for Lane Departure Warning (LDW) systems. To determine how such systems perform in real-world conditions, NHTSA recently worked with industry partners on the Integrated Vehicle Based Safety System (IVBSS) program, a large field operational study, that combined FCW, LDW and side object detection technologies.

Vehicle Safety Communications for Heavy Vehicles

For several years NHTSA has been working with light-duty passenger vehicle manufacturers to develop and test innovative wireless communication technologies that would allow vehicles to have enhanced "situational awareness" by continuously broadcasting their position and heading at a rapid rate. This information is then received and interpreted by other vehicles. Warnings are presented to drivers if a crash situation is developing or imminent.

NHTSA is now extending this research to include heavy trucks and buses, and will aggressively tailor the technology and applications as needed to work in the unique operating environment characteristic of heavy vehicles. NHTSA is working with commercial vehicle partners to research and test the use of DSRC based vehicle-to-vehicle communications as a means of enhancing the performance of existing collision avoidance systems (such as FCW and LDW), but also enabling new collision avoidance applications for heavy vehicles such as intersection movement assist (IMA)

Vision Enhancement

Blind spots around large combination vehicles contribute to lane change/merge crashes, a significant portion of crashes involving tractor semitrailer vehicles. To address this type of crash scenario, NHTSA is examining the potential use of camera/video imaging systems (C/VIS) to augment side mirrors and help the driver perform safe lane change maneuvers. NHTSA is reviewing both commercially available C/VIS products as well as developing advanced prototypes which enhance the selected features of these systems including the ability to provide 360 degree all-weather vision for the driver. Test trials with commercial vehicle drivers were completed to determine the potential safety benefits, driver acceptance, and overall system performance for C/VIS technology.

Human Factors Research

NHTSA's human factors research examines the interaction of driver, vehicle, and environment in order to improve driver-vehicle performance. The research supports Federal Motor Vehicle Safety

Standards, safety defects investigations, consumer information, and the advancement of knowledge about driver behaviors and performance. Findings are applied to the development of vehicle technologies, which are compatible with driver abilities and limitations. Main focus areas of the Human Factors program include: (1) Reducing unsafe driving behaviors by addressing driver distraction and driver impairment (alcohol, drowsy driving), (2) Improving the driver-interface (DVI) design of Crash Warning Systems, and (3) addressing vulnerable populations, such as blind pedestrians by developing human factors requirements for quiet cars,

Driver Distraction

NHTSA's mission is to "save lives, prevent injuries, and reduce economic costs due to road traffic crashes." One focus of this mission is the prevention of road traffic crashes for which driver distraction is a contributing factor.

In April, 2010 NHTSA released an Overview of the National Highway Traffic Safety Administration's Driver Distraction Program which summarized steps that NHTSA intends to take to help in its long-term goal of eliminating a specific category of crashes-those attributable to driver distraction (NHTSA 2010b). NHTSA's Driver Distraction Program consists of four initiatives as illustrated in Figure 10, and described below.

Figure 10. NHTSA Driver Distraction Initiatives

Of the areas described in the plan, the Human Factors program supports initiatives 1-3, which are:

1. *Improve the understanding of the extent and nature of the distraction problem*. This includes improving the quality of data NHTSA collects about distraction-related crashes along with better analysis techniques.
2. *Reduce the driver workload associated with performing tasks using both built-in and portable in-vehicle devices by improving the designs of device interfaces*. Better device interfaces will help to minimize the amount of time and effort involved in a driver performing a task using the device. Minimizing the workload associated with performing non-driving, or "*secondary,*" tasks with a device will permit the driver to maximize the attention they focus toward the *primary* task of driving.
3. *Keep drivers safe through the introduction of crash avoidance technologies.* These include the use of crash warning systems to re-focus the attention of distracted drivers as well as vehicle initiated braking and steering to prevent or mitigate distracted driver crashes.

Distraction Guidelines

Of the projects listed under Initiatives, 1-3, a main focus is to develop a set of Distraction Guidelines in support of Initiative 2 – Reduce Workload from Interfaces. As discussed in NHTSA's Driver Distraction Program, NHTSA's intent is to "develop voluntary guidelines for minimizing the distraction potential of in-vehicle and portable devices."

Drivers perform secondary tasks (communications, entertainment, informational, and navigation tasks not required to drive) using in-vehicle electronic devices by interacting with them through their user interfaces. The user interfaces of these devices can be designed to accommodate interactions that are visual-manual, auditory-vocal, or a combination of the two. Some devices may allow a driver to perform a task through either manual control manipulation with visual feedback, or through voice command with auditory feedback to the driver.

In general there are two functional categories based upon the mode of interaction: visual-manual and auditory-vocal. Visual-manual interactions involve the driver making inputs to the device by hand (e.g., pressing a button, rotating a knob) and visual feedback being provided to the driver. Auditory-vocal interactions involve the driver controlling the device functions through voice commands and receiving auditory feedback from the device. Note that a single device's driver interface could accommodate both visual-manual and auditory vocal interactions.

At the present time, NHTSA Driver Distraction Guidelines are being developed for application to in-vehicle device tasks that are performed by the driver through visual-manual means. The goal of the NHTSA Guidelines is to encourage the design of in-vehicle device interfaces that minimize driver distraction associated with secondary task performance. The Guidelines specify criteria and a test method for assessing whether a secondary task performed using an in-vehicle device may be acceptable for performance while driving. The Guidelines also seek to identify secondary tasks which interfere too much with a driver's ability to safely control their vehicle and to categorize those tasks as ones that are not acceptable for performance by the driver while driving.

Alcohol Detection Research: Driver Alcohol Detection System for Safety (DADSS)

Since 1997, about a third of all fatally-injured passenger vehicle drivers had blood alcohol concentrations at or above the legal limit. In order to address this problem, NHTSA entered into a five year cooperative agreement with the Automotive Coalition for Traffic Safety (ACTS) aimed at developing alcohol detection technologies with broad deployment potential. Desired technologies would be non-invasive, reliable, accurate, and precise. This program has been involved in the development and testing of alcohol detection prototypes and that may be installed in vehicles. The system prototypes are undergoing extensive laboratory and field testing. This five year effort will result in prototypes installed in test vehicles, and prevent alcohol impaired drivers from driving their vehicles.

Driver Impairment Monitoring

In 2010, the Impairment Monitoring to Promote Avoidance of Crashes using Technology (IMPACT) program developed real-time algorithms to detect driver alcohol impairment using vehicle-based sensors. The study developed two types of algorithm, a general algorithm that does not consider individual differences in driving and an individualized algorithm.

Ideally, one would desire both the capability of identifying impaired driving regardless of the source, and the capability of specifying the source of impairment. The IMPACT algorithms with slight modifications may present one or both capabilities in addition to detection of alcohol impairment. A follow on program, Advanced Countermeasures for Multiple Impairments (ACMI), aims to evaluate the breadth and specificity of the algorithms developed in IMPACT for use in detecting and distinguishing among multiple forms of driver impairment (alcohol impaired driving, drowsy driving, and distracted driving). The current phase of ACMI focuses on developing algorithms to detect drowsy drivers.

Collision Warning Interface Research

Recognizing the important role of the driver in crash avoidance systems, NHTSA is now focusing research on developing a better understanding of, and guidelines for, the collision warning interface for FCW and LDW systems. The work involves consideration of the unique driving environments for both light vehicle and commercial and heavy vehicle drivers. This work examines the effectiveness of various warning methods, determines the potential need for standardizing certain system features, and explores methods for objectively measuring the performance of interface solutions.

Quieter Car

Pedestrian safety can be compromised by modern vehicles, e.g. electric vehicles that produce little or no sound. The goal of this program is to understand the safety risks, characterize the acoustic environment, and identify possible countermeasures to enable pedestrians to detect the presence of vehicles in motion. Recent phases in the program have measured the effectiveness and acceptability of various countermeasures. Results will support agency rulemaking as directed by Congress, and reported elsewhere in this paper.

Data Collection and Analysis

NHTSA conducts a motor vehicle crash data collection program through the National Center for Statistics and Analysis (NCSA). It is composed of: the data collected from the states, including Fatality Analysis Reporting System (FARS) and the State Data Program. In addition, NHTSA also performs detailed crash investigations in the National Automotive Sampling System (NASS) Crashworthiness Data System (CDS) and the Special Crash Investigations (SCI) programs.

In the 1970s, NHTSA devised a method that utilizes a combination of State record and investigation based systems to provide nationally representative traffic crash data. The recoding of police-reported crashes from State record based systems into a uniform format provides counts and trends. T he detailed field investigations provide the details required for countermeasure development and evaluation. This sample based approach provides nationally representative data at a small fraction of the cost it would take to collect and manually recode the millions of police-reported crashes into a uniform format.

FARS is a State crash record based system that provides a census of all fatal crashes occurring on public roads in the United States. The NASS is comprised of the General Estimates System (GES) and the Crashworthiness Data System (CDS). The GES is a State crash record based system that provides national estimates calculated from the approximately 50,000 crashes collected annually to provide characteristics of all motor vehicle crashes. The CDS conducts detailed investigations into a nationally representative sample of approximately

4500 crashes involving towed passenger vehicles to investigate injury-causing mechanisms and to evaluate countermeasures.

The NASS infrastructure was utilized in two surveys to collect nationally representative data on the events and factors related to the causation of crashes. The Large Truck Crash Causation Study (LTCCS) was conducted by the National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA) from 2001 to 2003 collecting about 1,000 crashes providing information on the causes or contributing factors for large truck crashes. From 2005-2007, NHTSA conducted the National Motor Vehicle Crash Causation Survey (MMVCCS) which collected about 7,000 crashes providing nationally representative information on the events and factors related to the causation of light motor vehicle traffic crashes. The SCI program provides in-depth data on crashes where emerging issues may be of interest.

The Not-in-Traffic Surveillance (NiTS) system is a virtual data collection system designed to provide counts and details regarding fatalities and injuries that occur in non-traffic crashes and in non-crash incidents. The NiTS 2007 system produced an overall annual estimate of 1,747 fatalities and 841,000 injuries in non-traffic crashes and non-crash incidents.

NCSA also conducts key analyses of the collected data and publishes reports, including the Traffic Safety Facts Annual Report and Traffic Safety Fact Sheets. Copies of the most recent reports can be found at NCSA's web site using the following URL: http://www.nhtsa.gov/NCSA.

Significant Rulemaking Actions

Overview

NHTSA's vehicle Safety Rulemaking and Research Priority Plan provides complete details of the Agencies priority rulemaking efforts for the next two years (NHTSA, 2011a). The following provides a brief summary.

Improve Rear Visibility

This action pertains to FMVSS 111 and the Cameron Gulbransen Kids Transportation Safety Act of 2007 requiring regulation related to power window safety, rearward visibility, and rollaway prevention. On December 7, 2010, the agency published a Notice of Proposed Rulemaking (NPRM) proposing an image behind the vehicle be visible to the driver when in reverse. On February 28, the agency extended the comment period until April 18, 2011, and announced two public meetings to be held in March. A final rule publication is expected by December 31, 2011.

Sound for Hybrid Vehicles

This action pertains to the Pedestrian Safety Enhancement Act, to provide means of alerting pedestrians, especially those who are blind, to the presence of a motor vehicle in operation. Per legislation, the agency must initiate rulemaking by July 2012.

Heavy Vehicle Stability Control

After an extensive research program to evaluate the available technologies, an evaluation of the costs and benefits, and a review of manufacturer's product plans, NHTSA believes it is necessary to promulgate a new Federal standard that considers stability control systems on truck tractors and motorcoaches that address both rollover and loss of control crashes. Rollover and Loss of Control crashes' involving heavy vehicles is a serious safety issue that is responsible for 304 fatalities and 2,738 injuries. They are also a major cause of traffic tie-ups, resulting in millions of dollars of lost productivity and excess energy consumption each year. Suppliers and truck and motorcoach manufacturers have developed stability control technology for heavy vehicles to mitigate these types of crashes

Heavy Truck Tire Upgrade

This action pertains to FMVSS No. 119, applied to new pneumatic tires for motor vehicles with a GVWR of more than 4,536 kilograms (10,000 pounds) and motorcycles. This applies only to new tires, not to retreaded tires. On September 29, 2010, the agency published an NPRM proposing to upgrade FMVSS No. 119 by increasing the stringency of the endurance test, primarily by increasing the test speed, increasing the load, and lowering the inflation pressure, and adding speed rating labeling on the sidewall. A new high speed test with test speeds up to 75 mph was also proposed. An extended comment period closed on December 29, 2010. We expect to publish a Final Rule in 2012.

Keyless Ignitions

This action pertains to FMVSS 114, Theft protection and rollaway prevention. This rulemaking addresses three safety issues regarding Keyless Ignition systems: drivers' inability to shut down a moving vehicle, drivers failure to place the transmission in park before shutting off the vehicle (leading to rollaways when the driver exits the vehicle), and drivers inadvertently leaving a vehicle with the propulsion system active (leading to carbon monoxide poisoning if the vehicle is parked in a garage adjoining a living space). The agency expects to publish the NPRM in 2011.

Accelerator Control Systems

This action pertains to FMVSS 124, accelerator control systems. The issues are: (1) updating the throttle disconnection safety requirements and test procedures of the standard to better address electronic throttle control and alternative power trains; and (2) adding a new requirement for a brake-throttle override system on light vehicles. The agency expects to publish the NPRM in 2011.

Lighting

FMVSS No. 108 has been in existence since 1968. The standard had been amended over the years but has never undergone a comprehensive review. Regulated parties had stated that the standard was difficult to interpret because of its organization. In response to these concerns the agency sought to rewrite the standard to make it more understandable by adopting a simplified numbering scheme, to improve organization by grouping related materials in a more logical and consistent sequence, and to reduce the certification burden of regulated parties who previously needed to review a few dozen third-party documents. The agency issued a final rule on December 4, 2007. Several petitions for reconsideration of the Final Rule are under consideration and the agency will decided on these in 2011.

Speed Limiters for Heavy Trucks

In 2007, NHTSA was petitioned by the American Trucking Association and Roadsafe America to require the installation of speed limiting devices on heavy trucks. In response, NHTSA requested public comment on the subject and received numerous comments supporting the petitioner's request. The agency has granted the petition. The agency anticipates issuing a proposal in 2012.

Tire Aging

Tire Aging refers to the reduction in a tire's material properties, which over time leads to a reduction of its performance capabilities and could result in tire failure. As a result of the agency's comprehensive tire aging research program, we have developed a tire aging test protocol that includes 5 weeks in the oven, which is followed by roadwheel testing. The protocol is available in docket NHTSA-2005-21276. Validation tests are being conducted on several currently produced light vehicle tire models to evaluate their performance to the test protocol. After completion of validation testing, the agency will decide on the next steps in 2011.

Next Generation New Car Assessment Program (NCAP)

In the final decision notice published on July 11, 2008 (73 FR 40016.Docket No.NHTSA-2006-26555), NHTSA discussed possible future enhancement efforts (beyond the newly enhanced program) in frontal impact, side impact, rear impact, and rollover programs. The agency will consider updating injury criteria in frontal impact and side impact programs, adjusting the baseline injury risk in all three programs to ensure that vehicles are measured against a meaningful benchmark, revising testing protocols, and providing improved consumer information.

The agency also plans to conduct real-world crash data analyses to identify crash modes and additional beneficial advanced technologies for the NCAP program beyond electronic stability control (ESC), lane departure warning (LDW), and forward collision warning (FCW) systems.

Motorcoach Safety – Seat Belts and Structural Integrity

Between 1999 and 2008, there were 24 fatal motorcoach rollover events that resulted in 97 deaths. Seventy-six of those 97 were ejected from the motorcoach. The agency published a proposal to require lap/shoulder belts for all seating positions in motorcoaches on August 18, 2010. This rule is intended to prevent ejections and keep passengers in their seats, thereby mitigating fatalities and injuries in crash and rollover events. A final rule is expected in 2012. In addition, the agency is developing a proposal for enhancing motorcoach rollover structural integrity in 2011.

Child Passenger Safety

In 2005, the agency issued a proposal to further expand the applicability of FMVSS No. 213 to CRSs for children weighing up to 80 lbs by incorporating the Hybrid III 10-year-old child (HIII-10C) dummy into the standard. After publishing two supplemental notices in 2009 and 2010 to address technical issues, the agency is planning to issue final rules in 2011 to incorporate the HIII-10C dummy into Federal motor vehicle safety standards.

The agency has evaluated and enhanced a test procedure simulating a near side impact of CRSs in vehicle side crashes and has also evaluated a new 3-year-old side impact child dummy, "Q3s" for use in this test procedure. The agency will propose the test procedure, performance requirements and the new Q3s dummy for evaluating child restraints in side impact in 2011.

In February 2011, NHTSA announced its intent to launch a new initiative as part of the New Car Assessment Program to provide consumers with information from auto manufacturers about the specific child safety seats they recommend for individual vehicles (76 FR 10637, Docket No. 2010-00062). Vehicle manufacturers would recommend a minimum of three seats from each of the three child restraint system type categories, rear facing, forward facing, and booster, and would span across a range of price points. Participation in the program would be voluntary. Following a public comment period, NHTSA anticipates issuing a final notice of the program in 2012.

Roof Crush

On May 12, 2009, NHTSA published a final rule upgrading the requirements of FMVSS No. 216, "Roof crush resistance." For light vehicles, the rule doubles the amount of force the vehicle's roof structure must withstand in the specified test, from 1.5 times the vehicle's unloaded weight to 3.0 times the vehicle's unloaded weight. The rule also requires the vehicles to meet the specified force requirements in a two-sided test, instead of a single-sided test and established a new requirement for maintenance of headroom. Previously unregulated vehicles with a gross vehicle weight rating greater than 2,722 kilograms, but not greater than 4,536 kilograms, are now required to have a roof strength of 1.5 times the unload vehicle weight under the same test conditions. The agency estimated that the changes in this standard will prevent 135 fatalities and 1,065 nonfatal injuries annually. Manufacturers would have to begin producing vehicles that meet the standard during 2012 (2013 model year) and all new light vehicles would have to meet the standard by September 1, 2016 (2017 model year).

Ejection Mitigation

On January 19, 2011, NHTSA published a final rule establishing the new Federal Motor Vehicle Safety Standard (FMVSS) No. 226 on Ejection Mitigation (NHTSA 2011b). This standard will reduce the partial and complete ejection of light vehicle occupants through side windows in crashes, particularly rollover crashes. We estimate the final rule will save 373 lives each year and prevent 476 serious injuries when fully implemented. Manufacturers would have to begin producing vehicles that meet the standard during 2013 (2014 model year) and all new light vehicles would have to meet the standard by September 1, 2017 (2018 model year).

Safety of Electric Powered Vehicles

NHTSA issued a final rule in June 2010 to facilitate the development and introduction of fuel cell vehicles and the next generation of hybrid and battery electric powered vehicles. The final rule requires manufacturers to design their electrically powered vehicles so that, in the event of a crash, all high voltage components of the power train are either electrically isolated from the vehicle's chassis or their voltage is below specified levels considered safe from electric shock hazards.

Evolving Vehicle Safety Strategy

Safety technology continues to evolve at a fast pace. Government agencies, acting alone, cannot expect to keep up with this pace. NHTSA believes it must continue to explore collaborative models with all stakeholders, such as OEMs, suppliers, research centers, advocates, and other government agencies. These collaborative models provide for a more transparent technology development and implementation process, significantly reducing the time for advanced safety technologies to reach the consumer.

In sum, our Vehicle Safety Strategy is designed to proactively expand our focus on vehicle safety needs and to dynamically manage our safety programs in a culture of accountability and global leadership. It constitutes a method for managing our responses to vehicle safety needs through a flexible but disciplined approach that keeps pace with changing vehicle safety priorities over time. As new opportunities for vehicle safety emerge from our strategy, our methods will help to ensure a clear path of transition of these to main stream vehicle safety programs, such as those described through the body of this paper.

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